# Interim report re SANDAG – UCD agreement #A37682/MOU #5005298 as amended in September 2021 (AMENDMENT NO. 2 (S890571)) awarded to the University of California, Davis Wildlife Health Center, with additional reference to NCCP-Local Assistance Grants # P1750301 and #Q1986006 from California Dept. of Fish and Wildlife

**Report prepared by Dr. Winston Vickers and Dr. Fernando Najera, UC Davis Karen C. Drayer Wildlife Health Center**

**Date: Report updated May 25, 2023.**

## Introduction:

This quarterly report to SANDAG (first quarter 2023) relates to the project titled "Mountain Lion Linkage Assessment along SR's 76,78, and 79, and testing of Hazing Devices in Western San Diego County" (funded by the San Diego County Association of Governments), and The Nature Conservancy (TNC), with amendments / expansion in September 2021 to include testing of methods of mountain lion population monitoring and estimation, and development of plans for long term monitoring of mountain lion populations in San Diego County (hereafter "SANDAG-funded project") .

Projects funded separately but with goals that inform this SANDAG-funded project include a project titled "Santa Ana Mountains to eastern Peninsular Range Conservation Connectivity Infrastructure Planning Project for Interstate 15 and Closely Associated Roadways" (NCCP-LAG 1), the project titled "Estimation of the Population of Mountain Lions in the Santa Ana Mountains and Comparison of Techniques for Population Estimation and DNA Collection, Wildlife Photo Technology Development, and Development of a Long-term Monitoring Plan and Collaborations for Mountain Lion Populations in Regional NCCPs" (NCCP-LAG 2), and "Use of fecal DNA for genetic evaluation and population size estimation of the mountain lion population in the Santa Ana Mountains, and comparison of results with those from other non-invasive sampling techniques" (NCCP-LAG 3).

The named projects were both funded by the Natural Community Conservation Planning (NCCP) Local Assistance Grant (LAG) Program through the California Department of Fish and Wildlife. Though the NCCP-LAG 2 and 3 projects were focused on the Santa Anas population, the findings from that project have very directly informed this SANDAG-funded project.

In addition, The Wildlife Conservation Board has funded a project for The Nature Conservancy to oversee evaluation and planning for improving connectivity through the Temecula Creek undercrossing that, along with TNC-funded monitoring of I-15 culverts, has

further informed our knowledge of connectivity between the Santa Anas (SA) and eastern Peninsular Range (ePR) populations. This has in turn informed our interpretation of data in this report.

In-kind support has been provided to assist in the conduct of all of the above-named projects by San Diego State University's Santa Margarita River Ecological Reserve (SMER), the Western Riverside County Regional Conservation Authority (RCA), California Department of Transportation (Caltrans), California Dept. of Fish and Wildlife (CDFW), the UC Riverside the San Diego Zoo Wildlife Alliance. In addition, numerous owners of conserved lands in the region have cooperated with the projects via allowing land access for project activities.

The lead entity on this SANDAG-funded project is the Karen C. Drayer Wildlife Health Center at the University of California, Davis (UCD-WHC), with scientific collaborators from. US Geological Survey (USGS), California Department of Fish and Wildlife (CDFW), San Diego Zoo Wildlife Alliance (SDZWA), and The Nature Conservancy (TNC). Mountain lion research has been conducted by researchers from the UCD-WHC in southern California since 2001.

The previous quarterly report (4$^{th}$ quarter 2022) updated both long term and recent findings and activities up to the date of that report. This current report relates the results primarily of Tasks 2, 4, and 6 during the 1st quarter of 2023. For more overall detail on previous findings please see the previous quarterly reports.

The lead researcher and director of the project is Dr. Winston Vickers of the UCD-WHC. Dr. Fernando Najera joined the UCD-WHC staff in mid-March 2023 and has been working with Dr. Vickers on completing tasks associated with this project. Dr. Jeff Tracey is the primary collaborator with USGS, Dr.'s Jessica Sanchez and Charlie de la Rosa at SDZWA, and Trish Smith and Brian Cohen at TNC.

**This quarterly report will detail only findings from work during this 1$^{st}$ quarter of 2023 but will refer to findings from previous quarterly reports to SANDAG and CDFW.**

**NCCP-LAG 2:**

A comprehensive report was submitted to CDFW and SANDAG. It was attached to previous quarterly reports.

**NCCP-LAG 3:**

See previous quarterly reports and UCD-WHC annual report to CDFW for 2022 for results of non-invasive sampling in the Santa Anas in Orange, Riverside, and San Diego Counties.

Results of the analysis of scat collected across the Santa Anas and previous research projects including scat collections in the ePR by CDFW is being completed and will be submitted for peer review shortly. This analsyis will significantly inform monitoring plans for the San Diego County mountain lion population.

**This current SANDAG-funded project:**

**Task 1: Assessment of I-15 and other regional wildlife crossings.** This initial Task was completed and a report generated, but additional information from GPS-collared mountain lions and cameras that has been generated along I-15 since completion of that report.

A draft report of findings from April 2021 through March 2022 was attached to a previous quarterly report. As reported previously, one uncollared mountain lion was detected crossing I-15 from west to east in 2021 at the Temecula Creek Bridge and another one in the 4th quarter of 2022. No crossings in either direction have been recorded in the 1st quarter of 2023.

Previously we reported that two GPS-collared mountain lions had crossed I-15 west to east in Murrieta and Escondido respectively but both returned to the Santa Anas after 1-4 weeks. No further crossings by collared mountain lions have occurred since those two despite the UCD-WHC team having collared eight animals west of I-15 and one to the east during 2022-2023.

Our team continued working with Caltrans, USFS, TNC, and CDFW on planning for a possible new crossing structure south of Temecula and just north of the San Diego-Riverside County line. We are also in discussions with the above-mentioned entities about initiating camera monitoring efforts at crossing structures along I-10 since mountain lion connectivity between the ePR population and those to the north has also been shown by genetic studies to be significantly compromised. At least three CDFW collared animals have approached I-10 closely from the north in the area being contemplated for camera monitoring, but no crossings were detected based on collar data. Monitoring of I-15 crossings in the San Bernardino/San Gabriel Mountains by Caltrans and CDFW in consultation with our team is about to begin.

**Task 2: Test Mountain Lion Hazing / Deterrent Devices aimed at reducing livestock predation and associated mountain lion depredation permits.** Work on this task is in process.

**Deterrent Device Testing**

Due to the pending application for listing of the San Diego County mountain lion population as threatened under the California Endangered Species Act, CDFW has expanded increased requirements for lethal depredation permits to all of San Diego County. This regulatory step has made it more important that non-lethal tools be developed to assist owners

of small livestock in protecting their animals from mountain lions, and thereby further reduce mountain lion losses.

Throughout 2021-2023 we have had a number of opportunities to field test commercial deterrent devices ("Gadfly" (motion activated sound and light), "Foxlight" (random flashing lights), "Predator Guard" (constant light), "Squawk box" (random or constant sound), "Ora" (random or motion-triggered sound and light), other motion-triggered sound and light devices , and predator calls modified to emit human voices. We have also done limited testing of placing visual shielding around animal pens. Devices have been tested where a depredation has occurred, at bait or kill sites where mountain lions were feeding, and along travel ways. Many specific examples of responses have been outlined in previous quarterly reports, as well as the results of a project to test behavioral responses of mountain lions to hounds – the results of that work are in a publication currently in review.

In the 1st quarter of 2023 a lesser amount of testing could be conducted due to rainy conditions restricting access to dirt roads and most wildland sites where testing could occur. However, some testing occurred at the San Diego Zoo Wild Animal Park with both uncollared and collared animals in their conservation area, at fenced areas, and on a deterrent grid.

Our plans are to continue to test devices opportunistically at kill sites and bait sites on GPS-collared individuals, and to continue to test opportunistically at locations where depredations by collared or uncollared mountain lions have occurred, as well as along travel ways using deterrent grids at various sites in the study area. Team members are also continuing to advise livestock owners on better housing strategies for their livestock at any opportunity, and those education efforts are also accomplished via talks to local groups. Collaborations with other researchers and CDFW on this issue are also ongoing. CDFW has hired new conflict specialists in Region 5 that we have been communicating with about ways to improve livestock protection and reduce conflict and mountain lion losses.

**Task 3. Photograph Identification Software Development**.

As reported previously, over 4,000 photos, cropped and classified by view have been forwarded to Dr. Jeff Tracey who is working on software development for the purpose of individual identification. Dr. Tracey's work is funded by USGS.

**Task 4. Mortality Monitoring (and assessment of disease/toxins/DNA)**.

Recent analyses of puma survival data from across the state (Benson et al. 2023 – published March 20, 2023 in the Proceedings of the National Academy of Sciences) suggests that the eastern Peninsular Range population clusters with other populations that have the lowest annual survival of all the populations in the state. Causes of mortality are primarily

human-related – depredations, vehicles, and poaching. This finding amplifies the concerns that the eastern Peninsular population may be a "sink" relative to other populations, and that reducing mortalities is critical to its stability. The Santa Ana's population in Orange, Riverside, and San Diego Counties is in the middle tier of the populations in the state in terms of survival. The analysis found that the type of development patterns (rural development) that are common in San Diego County are factors in the populations throughout the state that have the lowest survival. The analysis also found that human attitudes as evidenced in voting patterns in relation to environmental issues play a role in mountain lion survival rates, with mountain lions having higher survival in areas with stronger voter support for environmental initiatives in general. The Benson et al. 2023 analysis suggests that human-related mortality of mountain lions in California appears to be additive versus compensatory, and potentially impacts these populations at the population level.

So far in 2023 we have recorded two mountain lion mortalities, one subadult or adult male on I-8 west of Pine Valley, and one female kitten in Orange County. The body of the male was taken by CDFW to one of their freezers which subsequently failed, making necropsy impossible. However we were able to get a sample of that animal's DNA. The kitten's body was badly macerated but will be taken to the California Animal Health and Safety lab for necropsy of the remains and DNA was also collected from her. She appeared to be an offspring of female F312 in the Santa Anas – a female that had 4 kittens in 2022 but who lost all 4 to various causes – 2 to cars, 1 to disease/abandonment, and 1 to unknown causes.

A new disease threat (H5N1 Avian Flu) has emerged in 2022-2023 and threatens not only birds but also terrestrial mammals, including mountain lions. Multiple mountain lions have died of this disease across the west, including 4 in California that have been confirmed. Three of those confirmed cases were in our UCD/IWS study area in NE California. We are being watchful for any signs of illness or death that could potentially be due to this virus in the mountain lions in southern California and are testing all captured and deceased mountain lions for the disease.

In relation to efforts to reduce vehicle-related mountain lion mortalities we have continued to work with Caltrans, TNC, and others on road improvement and fencing planning in the county. Efforts to reduce mountain lion mortalities should continue in the form of education, deterrent device development, highway fencing, and creating safe highway crossings.

As reported previously, with additional support from The Nature Conservancy, the NCCP-LAG program, CDFW, and individual donors, we have continued to collect high quality DNA and other biological samples from all captured and known deceased mountain lions in the UCD study area, as well as analyze DNA from scat samples collected in the Santa Ana range in

late 2022 and the ePR previously. DNA has been isolated from those samples, individual DNA fingerprints established where possible, and samples of the DNA forwarded to Dr. Jessica Sanchez at the San Diego Zoo for metabarcoding analysis for diet, various diseases, and toxins as described in previous quarterly reports.

Interestingly, and somewhat as a negative finding, despite the ability to match DNA fingerprints from those samples collected in the last two years in the Santa Anas (including in the San Diego County portion of the range on Camp Pendleton and adjacent lands) against all the DNA fingerprints from the ePR, no matches were found. Thus, no animals were detected west of I-15 that had been previously sampled in the last few years east of I-15 (scat survey in the ePR as well as tissue and blood samples). Thus, as has been the case previously, genetics are telling us that movement across that highway appears to be infrequent.

We are continuing the previously reported collaborations with CDFW (Dr. Mike Buchalski), the University of Wyoming (Dr. Holly Ernest), and Arkansas State University (Dr. Kyle Gustafson) to update genetic information and pedigrees relating to the ePR and SA Range mountain lion populations, as well as those we or CDFW have sampled in the San Bernardino/San Gabriel Ranges north of I-10. This information will add immensely to our understanding of connectivity between these mountain ranges. We expect that work to be completed in the summer of 2023. As reported previously, we continue to work with the Shapiro lab at UC Santa Cruz on whole genome analysis of DNA from lions in our area as well as across the state.

All deceased lions have been tested for exposure to anticoagulant rodenticides, and all have been positive for at least one, and usually more. These findings are consistent with previous results. Though no direct mortalities have been ascribed to these toxins, sublethal effects especially on immune function remain a concern.

In addition, whisker samples taken from captured and deceased mountain lions have been forwarded to the UC Davis lab for stable isotope analysis and that information will illuminate diets of the individual mountain lions over time. This is part of a statewide diet analysis being conducted by Kyle Dougherty in the John Benson lab at the University of Nebraska.

**Task 5: Continue Tasks 2-4 in 2022 –** see above

**Task 6 (2022): Literature and Results Review and Evaluation of Monitoring Technique Options:**

The UCD-WHC team conducted a literature and results review in the 3rd quarter of 2022 (see 3rd quarter 2022 interim report to SANDAG) and we continue to monitor and study the

relevant literature on scientific techniques that have been employed to monitor carnivore populations, especially mountain lion.

**Task 7 (2023): Continuation of Tasks 2-4.** These tasks are continuing in 2023.

**Task 8 (2023): Long-Term Monitoring Plan Development and Review:**
As of the date of this report, this task is underway and is building on the findings of the literature review and other input.

We are focusing on key methodologies that have been used to monitor carnivores, especially mountain lions, over large landscapes, as well as on combinations of methods. We have been consulting with collaborators at CDFW, Washington State University, UCD, the University of Nebraska, UC Santa Cruz, the San Diego Zoo Wildlife Alliance, and others who have conducted local, relevant studies as well as studies elsewhere.

We are using the results of studies that utilized scat DNA alone (Dellinger et al. in prep), GPS collars, combinations of hair, scat, swab, and tissue-blood DNA, along with cameras (Vickers et al. 2022), cameras alone, and hair alone to help establish pros and cons of each method. We have also reviewed a recently published meta-analysis of population estimation techniques for mountain lions (Murphy et al. 2022) to help establish best practices for monitoring the ePR population going forward.

We are accumulating information for estimation of costs associated with employing the different monitoring methods and best time periods to conduct each technique. Techniques other than the ones above are being investigated, along with various other combinations.

All of this information is being incorporated into a long term mountain lion monitoring plan for San Diego County that will be completed in late 2023.

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